DESIGN DETAILS AND SPECIFICATIONS
FOR A
WATER WORKS SYSTEM, BUCHANAN, MICH.

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Design Details and Specifications

For a Water Works System, Buchanan, Mich.

A T H E S I S

presented by

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of

A R M O U R I N S T I T U T E O F T E C H N O L O G Y .

for the degree of

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INTRODUCTION

In this system the water will be drawn from shallow driven wells and be distributed throughout the village by motor driven pumps. A reservoir will be provided which will serve to maintain a constant pressure and furnish a reserve supply.

The subject will be considered under the following heads:

Field work.
Mains, Hydrants and valves.
Pumpsmotors and pumping station.
Reservoir.
Specifications.

FIELD WORK

The field work which was done during the last week of January 1909, consisted of securing information and data from which a map of the village could be drawn and from which street grades could be determined.

A small atlas map of the village and a book giving the grades of some of the principal streets were found on file in the Clerk's office at Buchanan. These were verified and completed Grades and distances were taken with level and chain, elevations being secured at one hundred feet stations and at all street intersections. The plusses of street intersections, which were recorded, furnished data from which parts of the village, not mapped, could be platted. A line of levels was also run to the site decided upon for the reservoir. From the information obtained, in this manner, a complete map of the village was drawn, to a working scale, and profiles of all existing streets made.

MAINS HYDRANTS AND VALVES

Upon investigation it was found that the fire demands would determine the sizes of the larger supply mains. Assuming a two-way hydrant at the end of a street, gives a required supply through the main of 500 gallons per minute. A 6" main, with a velocity of 5.6' per second, gives the required quantity and will therefore be used. The loss of head from friction, at this velocity,is high, but as the hydrant at the end of a street, supplied from one direction only, is the exceptional and not the usual case, the main will not be made larger. The domestic supply required, during a fire, is quite small and will be provided for by cross street mains. This makes it possible to have the main supply pipes of uniform size throughout their length.

Six inch mains will therefore be laid in all north and south streets, connecting with a large supply pipe in Chicago Street, on which the pumping station will be located. A six (6) inch main, from the reservoir, will be connected with the general system in or near the pumping station, so that the reservoir can be cut off when fire pressure is being maintained. With the exception of Chicago Street, all east and west streets will be supplied by four (4) inch mains, connected at each intersection with the six (6) inch mains. From calculations for the fire pump, it is found that two thousand seven hundred and seventy-five (2775) gallons per minute will be the maximum flow into the mains.

A sixteen inch (16") main from the pump to the Chicago Street main with a maximum velocity of four and four tenths feet (4.4') per second will be used. The water divides and flows in two directions on reaching the street. A fourteen inch (14") main in Chicago Street, between Berrien Street and Clark Street, and a twelve inch (12") main in Chicago Street, between Clark and Detroit Streets will be arbitrarily chosen.

One two-way hydrant will be placed at each street intersection and in the middle of blocks longer than four hundred(400) feet.

Two valves will be placed in each north and south street, one on each side of, and adjacent to the large main in Chicago Street. A valve will be placed in the reservoir supply pipe, in or near the pumping station and one in the same pipe in the valve chamber near the reservoir. A valve will be put in the reservoir drain pipe, in the same chamber. The suction and discharge ends of the pump will each be provided with valves.

PUMP, MOTORS AND PUMPING STATION.

One pump will be used for both domestic and fire service. It will be run at its full capacity for fire service, by a motor used for this purpose only, a smaller motor being used to pump the domestic supply. Electric power will be used entirely due to the exceptional reliability and low cost of current furnished by a local company, operating several hydro-electric stations on the St. Joe River. The pumping station will be at the southeast corner of Chicago and Oak Streets. The size and lay-out are shown in the accompanying drawings. The calculations, on which the capacities of the pump and motors are based, are given below.

Assuming a yearly average rate of one hundred (100) gallons per capita, per day, a maximum daily rate of one hundred and fifty per cent. (150%) the yearly rate, and a maximum hourly rate of one hundred and fifty per cent. (150%) of the daily average, gives two hundred and twenty-five per cent. (225%) of the yearly average as the maximum hourly rate, exclusive of fire consumption. For a town of (10,000), the fire consumption may be taken at three hundred and sixteen per cent. (316%) of the yearly average, (Turneaure and Russell on Public Water Supplies) making a total maximum hourly rate of five hundred and forty per cent. (540%) of the yearly average. The probability of these maxima occurring simultaneously being remote, this will be reduced to four hundred per cent. (400%).

$$\frac{400 \times 10{,}000}{24 \times 60} = 2775$$

gallons per minute to be supplied by the pump during a fire.

The elevation of the intersection of Chicago and Oak Streets, where the pumping station will stand is forty-nine feet (49') above village datum. Assuming the water surface in the wells at datum, the head to be pumped against, to raise water to the highest point to be supplied, (Hobart Street) is one hundred and twenty feet (120'). Since a hydrant pressure of seventy-five pounds (75#) per square inch will be maintained at this point, the total head to be pumped against is 120 - 75 X 2.304 = 293'. The capacity of the pump is therefore, two thousand seven hundred and seventy-five (2775) gallons per minute against a head of two hundred and ninety-three feet (293'). These quantities, with the pump efficiency, will determine the size of the motor.

The same pump will be used for domestic service. The domestic supply will be assumed at the yearly average of one hundred (100) gallons per capita per day while any excess above this rate will be provided by the reservoir of three hundred and sixty thousand (360,000) gallons capacity. The motor for domestic service will be required to pump the daily average supply of one million (1,000,000) gallons in ten (10) hours, or

$$\frac{1{,}000{,}000}{10 \times 60} = 1660 \text{ (approximately)}$$

gallons per minute. To supply a domestic pressure of thirty pounds (30#) at the highest point in the village, the water must be pumped against a head of
120 - 30 X 2.304 = 200' (approximately).
This quantity, one thousand six hundred and sixty (1660) gallons against a head of two hundred feet (200'), with the pump efficiency, will determine the size of the domestic service motor.

RESERVOIR

The reservoir which will be constructed of reinforced concrete throughout, will have a capacity of three hundred and sixty thousand (360,000) gallons. This is equivalent to a four (4) hours supply at two hundred and twenty-five per cent. (225%) of the average yearly rate and will serve as a reserve. The elevation of the highest point to be supplied is one hundred and twenty feet (120') making the required elevation of the bottom of the tank, to provide thirty pounds (30#) domestic pressure, approximately two hundred feet (200'). The elevation of the hill on which the reservoir will be placed, is two hundred and eleven feet (211'), which will allow for sinking the reservoir to the depth necessary for protection against freezing.

The quantity three hundred and sixty thousand (360,000) gallons is equal to forty-eight thousand (48,000) cubic feet. Assuming a sixty foot (60') square as the interior plan of the reservoir, the required depth

$$y = \frac{48{,}000}{60 \times 60} = 13.4 \text{ feet.}$$

This will be increased to fourteen and one-half feet (14.5') to allow for rounded corners and columns. The reservoir will be divided into four bays in each direction, by lines of columns. In one direction will run girders supported by the columns and side walls. In the other di-

rection will be beams supported by the girders with their tops flush with the tops of the girders. On the beams will rest the roof slabs. A two foot fill of earth and a snow load of fifty pounds (50#) per aquare foot will be assumed on the slab, making a total load of two hundred and fifty pounds (250#) per square foot.

Roof Slab.

Span between beams equals five feet (5').
On a width of slab of one foot (1') the load per foot, w = 250#. M = bending moment.

$$M = \frac{12wl^2}{8} = \frac{12 \times 25 \times 25}{8} =$$

9340 inch pounds.

$M = Kbd^2$, where "b" = breadth and "d" = depth of beam, both in inches.

If the ratio

$$\frac{\text{modulus of elasticity of steel}}{\text{modulus of elasticity of concrete}}$$

$$= \frac{E_s}{E_c} = 15,$$

the allowable compression in concrete = 500# per sq. in.
the allowable tension in steel = 16,000# per sq.in.
Percentage of steel = .035

Therefore K = 151, by the parabolic theory of stress in concrete.

$$\text{Therefore } d = \frac{9340}{12 \times 151} = 2.25 \text{ inches.}$$

Amount of steel required = .035 X 2.25 = .945 sq. in. per foot of width.

Floor Beams.

$$l = 15 \text{ feet.}, \quad w = 5\left(250 + \frac{150}{4}\right)$$

= 1437 pounds.

$$M = \frac{1437 \times 15^2 \times 12}{8} =$$

485,000 inch pounds. = Kbd^2

Assume width equal to one-half the depth of beam,

$$d = \sqrt[3]{\frac{485{,}000 \times 2}{151}} = 18.6 \text{ inches.}$$

Beam will be made 9" X 21".

$$\text{Area of steel} = .035 \times \frac{18.6^2}{2} =$$

6.06 sq. in.

Depth will be measured from top of roof slab, since slab is not otherwise compressed over beam.

Girders

l = 15 feet. Two concen-

trated loads, one at each end and five feet (5') from the end.

Each load =

$$1437 \times 15 + \frac{10 \times 20 \times 15}{1728} \times 150$$

= 23,960 pounds.

$M = 23,960 \times 5 \times 12 = 1,440,000$ inch pounds $= Kbd^2$; $b = \frac{1}{2} d$.

$\therefore 1,440,000 = 75.5\ d^3$.

$$d = \sqrt[3]{\frac{1,440,000}{75.5}} = 26.7".$$

Beam will be made 13" X 30", measuring depth from top of slab.

Area of steel $= \frac{.035 \times 26.7^2}{2} =$

12.4 sq. in.

Columns

The load on each column =

$$15 \times 15(250 + \frac{150}{4}) +$$

$$3\left(\frac{10 \times 20 \times 12 \times 15}{1728} \times 150\right) +$$

$$\frac{15 \times 12 \times 13 \times 30}{1728} \times 150 =$$

66,430 pounds.

Turneaure and Maurer give the column formula:

$$P = fc\ A[1 + (n - 1)p]$$

where P = load, in pounds, to be supported.
fc = allowable compression per sq. in. for concrete.
A = area of cross section of column.

$$N = \frac{E_s}{E_c}.$$

$$p = \frac{\text{area of steel in cross section}}{\text{area of concrete in cross section}}.$$

$$\therefore\ 66{,}430 = 500\ A[1 + (15 - 1).035].$$

A = 90 sq. in.

Column will be made 10" square.

Column Footing.

The load on each column is 66,430 pounds. Assuming a bearing value for the soil under the footing of 1-1/4 tons per sq. ft., the required area of footing =

$$A = \frac{66430}{2500} = 26.6 \text{ sq. ft.}$$

Footing will be made five feet (5') square. The footing acts as a cantilever of length,

2'-5" - 5" = 25".

$$w = \frac{2500}{12} = 208 \text{ pounds per inch of length.}$$

$$M = \frac{wl^2}{4} = \frac{208 \times 625}{4} = 32500 \text{ inch pounds.}$$

$$= Kbd^2$$

$$\therefore d = \frac{32500}{12X151} = 4.25 \text{ inches.}$$

Since the footing does not act as a cantilever, except for the section directly under the column, an arbitrary design with 3/4" bars in three directions will be made.

(See Drawings)

DEPTH OF EXCAVATION FOR RESERVOIR

To provide against freezing, the reservoir will be covered to a depth of two feet (2') on the roof, and the sides will be banked. The depth of excavation necessary to obtain earth to cover the roof and slope down the sides at a slope of 1-1/2:1, to the natural ground surface, will be calculated.

The total depth of reservoir, from top of floor to top of roof slab, is 14.5' - 2.5' = 17'. If the distance from top of floor to the natural ground line is 4' - 2' = 6', and a shrinkage of ten per cent. (10%) of excavated material be allowed,

$$1.1 \times 4 \times 60 \times 1.5(17 - x) \times 1/2(17 - x) = x(60 \times 60)$$

$$x = 6.3 \text{ feet.}$$

Adding one-half foot (1/2') for the thickness of the floor slab, gives a total depth of excavation necessary of 6.3' - 0.5' - 2' = 9' - 00".

WALLS

The wall will be designed as a retaining wall, although the roof system, built as it is, will cause it to react against lateral pressure, to some unknown extent, as a beam supported at both ends. The assumption of cantilever action is on the side of safety. The earth against the wall will be assumed to weigh one hundred pounds (100#) per cubic foot and have a critical angle of forty-five degrees (45^{o}). The earth pressure will be assumed to be the same as if the ground line were on a level, with the top of the tank.

$$\frac{p}{q} = \frac{1 - \sin\phi}{1 - \sin\phi}$$

where p = unit vertical pressure.
q = unit horizontal pressure.
ϕ = critical angle.

Therefore q = 17.2 pounds per sq.ft.

Q = the total horizontal thrust

$$= \frac{17.2^2}{2} X\ 17.2 = 5630 \text{ pounds, per}$$

foot of length of wall acting 17.5/2 = 5.84 feet above the base.

The weight of the roof resting on the wall will be included in the calculation. Each fifteen feet (15') of wall will bear one-half a column load = 33215

pounds except at the corners where the load will be one-quarter of a column load. The arch action at the corners will amply provide for the less weight at the point. This load is equivalent to 33215/15 = 2210 pounds per foot of wall. For a length of wall of one foot (1'), upon which calculations will be based, the downward pressure, through the center of gravity of the wall, assuming a uniform thickness of wall of fifteen inches (15"), and a weight of concrete of one hundred and fifty pounds (150#) per cubic foot, is

$$W = 17\frac{1}{2} \times 1\frac{1}{4} \times 150 - 2210 = 5490 \text{ pounds.}$$

A base measuring four feet (4') in each direction from the outside face of the wall, will be assumed.

The weight of the prism of earth on the heal of the wall is

$$W_1 = 4 \times 17\text{-}1/2 \times 100 = 7000 \text{ pounds}$$

acting two feet (2') from the back face of the wall. Considering the reservoir empty, the resultant downward pressure = 7000 - 5490 = 12490 pounds acting at

$$\frac{7000 \times 2 - 5490 \times 4.625}{12490} = 3.16 \text{ feet}$$

from the edge of heel or .84 feet from the back face of wall. The resultant of the horizontal and downward forces cuts the base of the wall at a distance

$$x = \frac{5630}{12490} \times 5.84 = 2.63 \text{ feet}$$

from the line of action of the resultant downward pressure of 1.79 feet in from the back face of the wall.

By the theorem of the middle third,

$$px = po + po\frac{12x_o x}{b^2} .$$

Where px = unit pressure at any point at a distance x from the center of gravity line (line of resultant downward pressure), po = unit pressure on the base $= \frac{W}{f}$, x_o = distance from line of resultant downward pressure to a point at which the resultant of the horizontal and downward pressure cuts the base. Therefore for the assumed base of eight feet (8'), the unit pressure under the toe of the wall is

$$px = \frac{12490}{8} + \frac{12490}{8} + \frac{12 \times 2.63}{8} = 4.84$$

= 4290 pounds per sq.ft.

This pressure is permissible but will be much diminished by the action of the floor slab which is a continuation of the toe and into which the toe reinforcement will extend. The pressure under the heel is,

$$px = \frac{12490}{8} + \frac{12490}{8} + \frac{12 \times 2.63}{64} (- 3.16)$$

= - 780 pounds per sq.ft.

Zero pressure occurs at x = - 2.14' or 1.02 from the edge of the heel.

Section through heel at junction of wall with heel.

The bending moment is equal to the algebraic sum of the moments of all the fore forces on the left of the section about the section.

$$M = -7000 \times 2 - \frac{780}{2} \times 1.02(.68 - 3) -$$

$$\frac{3 \times 4290}{7} \times 3 \times 1 = -12704 \text{ foot pounds} =$$

152,450 inch pounds.

$M = Kbd^2$

$$\therefore 152450 = 151 \times 12 \times d^2$$

$$d = \frac{152450}{151 \times 12} = 9.2 \text{ inches.}$$

It will be made twelve inches deep.

Area of required steel = .035 X 9.2 X 12 = 3.85 sq.in. per foot in top of section.

Section through toe at junction of wall with toe.

$$M = \frac{3 \times 4290}{7} \times 2.75 \times \frac{2.75}{2} -$$

$$\left(4290 - \frac{3 \times 4290}{7} \right) \times 2.75 \times 2/3 \times 2.75$$

$$= - 6960 - 6190 = - 13150 \text{ foot pounds.}$$

$$= 158000 \text{ inch pounds} = 151 \times 12 \times d^2$$

$$d = \frac{158000}{151 \times 12} = 9.35 \text{ inches.}$$

It will be made twelve inches deep.

Area of steel required = .035 X 9.35 X 12 = 3.93 sq.in. per foot in bottom of section.

Section of wall at junction with base.

M = 5630 X 4.84 = 2725 foot pounds = 32650 inch pounds = $151 \times 12d^2$.

$$d = \frac{32650}{151 \times 12} = 4.25 \text{ inches.}$$

The stresses due to column action in the wall are uncertain and convenience in construction requires more thickness than is theoretically required, so the section first assumed will be used. Present practice in this work would seem to justify even a heavier section.

Wall stresses with reservoir full.

When the reservoir is full, the resultant horizontal water pressure is $14.5^2/2 \times 62.5 = 6550$ pounds applied at $14.5/3 + 1/2 = 5.34$ feet from the base of the wall. This force combined with the opposite earth pressure gives a resultant outward movement of 2000 foot pounds which will be provided for by reinforcement arbitrarily placed in inner face of wall. (See wall detail in drawing).

Floor Slab.

Since the stresses in the floor

slab can not be satisfactorily calculated, an assumed section in keeping with existing work, of the kind, will be chosen. A six inch (6")slab, reinforced near the upper surface, with one-quarter inch (1/4") rods in two directions, six inches (6") center to center, will be used.

Horizontal reinforcement in the walls to provide for temperature stresses, will be chosen arbitrarily. The uniform temperature which will be maintained, justifies the provision of no expansion joints.

Two manholes, with perforated lids will be provided to serve for means of entrance and for ventilation. Necessary supply, overflow and drain pipes will also be provided.

GENERAL SPECIFICATIONS AND CONDITIONS OF AGREEMENT.

The work will be considered and detailed specifications are drawn under the following divisions:

1. Furnishing hydrants, valves and valve-boxes.
2. Furnishing cast iron pipe and special castings.
3. Laying pipe and setting hydrants, valves and valve-boxes.
4. Driving and casing six inch (6") wells.
5. Furnishing material for and erecting reinforced concrete reservoir, including foundation, connections, etc.
6. Furnishing and setting up pumping machinery.
7. Building pumping station.
8. Furnishing and setting up motors.

Bidders will divide their bids, giving prices for the work under the separate divisions mentioned above, together with a lump bid for the construction of the complete plant, on blank forms to be obtained of the Village Clerk. Separate items are introduced to cover any slight variations over or under the amounts herein estimated or specified and the contractor hereby agrees to such extension or reduction at the prices named.

It is intended that these specifications, and each contract and specifica-

tions shall cover the completion of the work to which it relates.

By the term "Village" is meant the village of Buchanan, Michigan, acting through its proper authorities.

Wherever the term "Engineer" is used, whether in the general or detailed specifications, it shall be understood to refer to _____, in the employ of the village, having direct charge of the water works construction, and to his authorized assistants.

Wherever the word "Contractor" is used, it shall be understood to refer to the party or parties contracting to perform the work to be done under these general and detailed specifications, or the legal representatives of such party or parties.

Bids will not be received for the work involved under these specifications, except from parties having had experience in such work, and who can furnish satisfactory proof of their ability to carry on the construction of the whole system in a thorough and workmanlike manner.

The contractor is to furnish at his own expense and cost, all transportation, plant, tools, labor, materials, and all else requisite to execute and complete the work in the best possible and most expeditious manner, and according to the drawings and specifications and their intended meaning.

He shall employ competent fore-

men and experienced mechanics and laborers, and shall discharge immediately, whenever requested by the engineer so to do, any man who is incompetent or disposed to be disorderly, and shall not again employ such person upon the work.

All materials furnished and work done, will be inspected by the engineer, and if not in accordance with these specifications and contract, they will be rejected and immediately removed, and other work done and material furnished in accordance therewith. All labor necessary to the proper inspection of the work and material shall be furnished by the contractor. If the contractor refuses to remove the work and materials as above ordered, then the engineer will have the right and authority to stop the contractor and his work at once, and to supply men and materials at the cost and expense of the contractor; such expense to be deducted from any moneys then due, or to become due to the contractor from the village.

And it is further intended that inspection shall not relieve the contractor from his responsibility to do true accurate work; and the contractor shall furnish all necessary facilities, should it be deemed advisable to make any examination of the work already completed. If any be found defective in any respect, he shall defray the expenses of such examination and satisfactory reconstruction. If all be found satisfactory, such expenses will be paid by the village. The engineer shall have the right to reject, at any time previous to the final settlement with the contractor,

any work or materials which may be found faulty, even though such faults may have been previously overlooked.

The successful bidder must sign the contract for the work to be done by him, within ten (10) days after the contract is awarded him and he shall proceed with the work, prosecuting it with due diligence from day to day, and complete it within at least eight (8) months from time contract is awarded him.

The contractor must follow strictly and without delay, all orders and instructions given by the engineer in the performance of his work. In the event of the contractor's absence from the work, he must leave it in charge of a duly authorized representative, to whom orders and instructions may be given. If he fails to do this, then the contractor will be held responsible for the proper carrying out of such orders and instructions as it may be necessary for the engineerto give to any superintendent,foreman or other employee about the work.

The contractor will be held responsible for the entire work until completed and accepted by the village, and until he is formally released from his obligations. He is required not to assign or sub-let his contract without permission from the village, but must keep it in his name and control until completed and accepted, and in case of his absence from the work, must have a duly qualified person to take care of it.

No charge shall be made by the contractor for any delays or hindrances from any cause during the progress of any portion of the work embraced in his contract.

If the delay is caused by any act or neglect of the village, then he will be entitled to an extension of the time allowed for the completion of the work, sufficient to compensate for the delay, provided the contractor shall give the village immediate notice of the cause in writing. If the contractor fails to complete the work at the date specified, he shall forfeit to the village, as confessed and liquidated damages, the sum of one hundred (100) dollars per day for each and every day the final completion is delayed beyond the time specified, and shall become liable for the salary of the engineer and his assistants for each and every day that the completion of the work extends beyond the time expressed in the contract.

Before the work will be considered as completed, all rubbish and unused material due to, or connected with the construction, must be removed and the premises left in a condition satisfactory to the village. All sidewalks and cross walks must be cleared up; streets, curbs, crosswalks, sidewalks, fences and other public and private property disturbed or damaged, must be restored to their former condition, and final settlement will be withheld until such work is finished.

Should any disagreement or difference arise as to the true meaning of

the drawings or specifications at any point, or concerning the character of the work, the decision of the engineer shall be final and conclusive and binding on all parties to the contract.

The village reserves the right to increase or decrease the quantity of the work, or any part thereof, to the amount found necessary. No allowance will be made, in case of increase, for any sum above the rate of price bid, nor in case of decrease for any real or supposed damage or loss of profit occasioned by such diminution. The time fixed for the completion of the work will be proportionately increased or diminished.

During unsuitable weather all work must stop when such work would be liable to be injured, and it must be suitably protected from such possible injury.

There will be no extra work, unless the same is done upon the written order of the engineer. Subject to this condition, extra work will be paid for according to schedule of prices bid. Where prices for the work are not included in the schedule, ten per cent. advance upon the actual cost, as determined by the engineer, will be paid to the contractor. Extra work done without the written order of the engineer, will forfeit all claims for same.

All village, county, or state laws, ordinances or regulations limiting or controlling the action or operation of those engaged upon the work, or affecting

the materials applied to them, must be respected or attended to.

The contract will be required in his contract to preserve the village harmless from all claims for damages, from any and all causes and natures, whatsoever, in connection with his work, or any part thereof, and also to act as defendant in each and every suit of any and every nature which may be brought against the village by reason of, or connected with the work done under this contract.

A final estimate of all work done and materials delivered according to the contract and these specifications, will be made as soon after the engineer has been notified of the completion of the work, as he can satisfy himself by tests, examinations or otherwise, that the work has been and is finally and fully completed in accordance with the contract and specifications, and the contractor will be paid as hereinafter provided. Before such settlement will be made, the contractor must satisfy the village that all bills for labor and materials used in the work, have been paid.

The contractor will be furnished with one set of drawings, prints or tracings, and a set of specifications, giving all the details and dimensions necessary for carrying out his portion of the work. Dimensions given in figures will have the preference over the scale where there is any discrepancy.

If the bidder does not fully under-

stand the plans and specifications, or is in doubt as to the engineer's ideas and intentions concerning any part or portion of the work, he must satisfy himself by inquiry of the engineer before bidding, for he will be held rigidly to the engineer's interpretation of the plans after the contract is drawn. The plans and specifications are intended as complete, but should anything be omitted from them, which is necessary to complete the work in accordance with the apparent intentions of the engineer, it will be supplied by the contractor, and at no extra cost to the village. Any work done by the contractor, which is strictly extra work, will be settled for as provided above.

All materials, lines and grades must be in full accordance with the plans, and no deviation from the plans and specifications will be allowed, except by written authority of the engineer.

The copy of plans and specifications furnished the contractor must be kept constantly at the work, must be well cared for and returned to the engineer when the work is completed.

The engineer will stake out all the work and set all necessary grade stakes, and the contractor is required to preserve all stakes, bench marks, etc., set or established along the line of the work, until duly authorized to move them. If moved by carelessness, or without authority, they will be set, if needed, at the expense of the contractor.

Each bid for the work must be accompanied by a certified check or its equivalent, as a guarantee that the bidder will enter into a contract with the village to do the work according to the plans and specifications and for the amount of the bid. The amount of such check shall be three thousand dollars ($3,000.00).

This deposit will be retained and placed to the credit of the party whose bid is accepted, and will be forfeited if he fails to enter into and execute the contract awarded him.

In case of the failure of the bidder, to whom the contract is awarded, to sign the contract, the village reserves the right to accept any other bid made, and all checks will be held until the contract is signed, when they will all be returned.

As security for the proper performance of the work a bond acceptable to the village of an amount at least equal to the contract will be required, and this bond will be retained by the village until the completion of the contract and its formal acceptance by the village, when it will be returned to the contractor.

Proposals must be enclosed in sealed envelopes, and each must have written on it plainly, the words, "Proposals for Water Works". Each proposal must be addressed to the Village Clerk of the village of Buchanan, Michigan.

All work done must be in strict

accordance with the detail specifications under their appropriate headings, and the general and detail specifications will be attached to and made a part of each contract. The general specifications and conditions of agreement are to be considered a part of the detailed specifications for each part of the work.

The village shall furnish the contractee all necessary permits for laying pipe in all alleys and streets, as well as permits from the railroad company for laying pipes under their tracks. The town shall furnish the land for the pumping station and water tank.

The village shall provide a superintendent or engineer to inspect the work while in progress, who shall have authority to make necessary changes in plans, order extra work, where necessary, etc., and to represent the Village Board in matters requiring prompt attention.

The contractor must comply with all the terms, requirements and conditions herein specified to be performed by him, and to complete said water works and all things connected therewith, both as to manner and time to the full satisfaction and acceptance of the engineer and the Village Council of Buchanan, Michigan.

The right is reserved to reject any and all bids.

SPECIFICATIONS FOR FURNISHING HYDRANTS, VALVES AND VALVE BOXES.

There will be required for the distributing system, the following valves, these numbers being chosen upon close approximation.
One (1) sixteen (16) inch gate valve.
Two (2) fourteen (14) inch gate valves.
Twenty-seven (27) six (6) inch gate valves.
Nine (9) four (4) inch gate valves.

The valves shall be of the best quality made and of a design approved by the engineer. Bidders will state in their proposal what manufacture of gates they propose to furnish.

They must be of what are termed "heavy" and must be tested to stand successfully and remain water tight under a pressure of three hundred (300) pounds per square inch at the factory.

The contractor will be required to guarantee their perfect condition for a period of one (1) year from the date of final acceptance of the work, and to pay all expenses and damages which may be incurred in keeping them in perfect order for that length of time.

The valves will be made to open by turning the key to the left. They must be suitably coated.

The net area of the water-way

must not be less than the net area of the pipe of the same nominal diameter, and in all particulars the valves must be of the best form and make, and proportioned for strength, durability and ease of working.

Defective valves will not be accepted, but will be stored, subject to the contractor's order and at his expense and risk.

The right is reserved to vary the number, kinds and sizes to such an extent as may be necessary for the interest of the work.

Proposals must state the price per piece for each size, for use in case of increase or diminution in the quantities.

HYDRANTS

The hydrants must be of the very best quality made frost proof and of a design to be approved by the engineer. Bidders will state in their proposals what manufacture of hydrants they propose to furnish. They must be made of the best materials, such as will be durable and will insure perfect ease and freedom of motion for every moving part.

Bidders will specify the size of gate or valve opening and inside diameter of stand pipe.

The character of the design must be such that all parts are easily accessible, and that repairs may be made at a minimum cost and in a very short time.

The drip must be such as will drain the hydrant perfectly, leaving no water standing in the stand pipe above the connecting pipe; such as will operate positively and certainly; so designed as to render it impossible to become clogged by anything liable to get into the water mains, or by roots; and such as will not easily get out of order or be difficult to repair.

The hydrants will be of proper length to use where the bottom of the pipe trench is to be five (5) feet below the surface grade. They will be designed to open to the left.

The nozzles will be cut with the Corporation thread. The gate or valve

must be so designed as to operate easily and freely and not be liable to be clogged or stuck by small pieces of foreign matter, and must be made of or faced with a material which is durable and not easily injured, which will not be liable to injure or stick to its seat, and such that should any slight injury occur to the seat or gate face, the valve will not leak.

Prices will be submitted per piece for the following;

Sixty-seven (67) hydrants with six (6) inch bottom connections, two (2) two and one-half (2-1/2) inch nozzles. Nineteen (19) hydrants with four (4) inch bottom connections, two (2) two and one-half (2-1/2) inch nozzles.

Defective hydrants will not be accepted, but will be stored at the contractor's risk and expense and held subject to his order.

He will be required to guarantee the perfect working of the hydrants for a period of one (1) year from the date of the final settlement and pay all expenses and damages which may be incurred in keeping them in perfect working order for that length of time.

All hydrants must be tested and stand satisfactorily, a pressure of three hundred (300) pounds per square inch at the factory.

VALVE BOXES

There will be required thirty-nine (39) cast iron extension valve boxes with five inch (5") diameter upright shaft, to be acceptable to the engineer for the valves above specified.

Prices must be named per piece for the valve boxes to fit the valves mentioned in the foregoing list, set in mains laid in trenches five feet (5') deep.

All valves and hydrants, after being set, must stand satisfactorily, the test specified for the mains after being laid, viz: a pressure of one hundred and fifty pounds (150#) per square inch, as shown by a correct gauge to be attached to a hydrant or hydrants, in the village, at the points to be designated by the engineer, for such a length of time as the engineer may desire, in order to satisfy himself of the perfection of the work.

The hydrants will be tested with the valve or gate closed; also with the nozzle caps on and the gate or valve open, and each and every defect must be repaired, and at no expense to the village.

The contractor or contractors will be required to contract to preserve and protect the village from all claims of infringement of patented articles, and to defend any and all infringement suits brought against the village, growing out of, or due to the use of their hydrants, valves and valve boxes.

Drawings or models should accompany each bid.

DETAILED SPECIFICATIONS FOR FURNISHING CAST IRON PIPE AND SPECIAL CASTINGS.

The pipes shall be made with hub and spigot joints and in general each straight pipe shall be about twelve feet (12') in length exclusive of the socket. The metal shall be of the best quality for the purpose, made from what is commercially known as "Neutral" Pig-Iron, which shall have been made from iron ores without the admixture of cinder, and when cast into the pipe the metal shall be tough, and of such density and texture as will permit its being easily cut and drilled by hand.

The pipe-metal must possess a minimum tensil strength of at least eighteen thousand (18000) pounds per square inch.

All the straight pipes shall be cast in dry sand moulds, vertically with the hub down. Every pipe is to have the initials of the maker's name cast distinctly upon it, and also the year; the figures and letters to be at least two inches (2") in length, with a proportionate width; the weight of each pipe to be conspicuously painted on the outside, before delivery, with white lead paint at the contractor's expense.

The pipes and special castings shall be free from scoria, sand holes, air bubbles and other defects or imperfections; they shall be truly cylindrical in the bore, straight in the axis of the straight pipes, and true to the required curvature or form in the axis of the other pipes;

they shall be internally of the full specified diameters, and shall have their inner and outer surfaces concentric. To insure proper diameters of sockets and spigots, a circular iron template of the required dimensions shall be passed to the bottom of every socket, and a circular ring over every spigot. Care shall also be taken to avoid all excess in diameter of the sockets, and no plugging or filling will be allowed. All pipes and special castings with defective hubs or flanges will be rejected.

After being taken from the moulds the pipes and special castings shall be thoroughly cleaned and then heated in a suitable oven to a temperature of from 350 to 400 degrees Fahrenheit, after which they are to be coated by dipping in a bath of Mineral Rubber Pipe Dip or any pipe coating material equal thereto. The bath must be heated in such a manner as to insure a constant and even temperature of 400 degrees Fahrenheit. As the temperature of the bath governs the thickness of the coating, care must be exercised in the maintenance of this temperature to avoid getting an uneven or thin coating.

The coating must be durable, smooth, glossy, hard, tough, perfectly water-proof, not affected by any salts or acids found in the soil, free from bubbles or blisters, strongly adhesive to the iron under all circumstances, and with no tendency to become soft enough to flow when exposed to the sun in summer, or to become so brittle as to scale off in winter.

After the said coating has become thoroughly set and hard, every pipe shall be subjected to a proof by water pressure of three hundred (300) pounds per square inch. Each pipe while under the required pressure, shall be sharply rapped from end to end with a hand hammer, to ascertain whether any defects have been overlocked; and any pipes which may exhibit any defects by leaking, sweating or otherwise, shall be rejected.

All pipes and castings must be delivered in all respects, sound and in conformity with these specifications. Upon their delivery at the points designated, the engineer reserves the right to subject the said pipes and castings to the same water-pressure proof and hammer tests as are above specified to be applied at the foundry; and all defective pipes and castings which may have passed the inspector at the foundry, or which may have been broken in transportation, will be rejected when there discovered, unless the same may be cut as herein provided. Care must also be taken in handling the pipes and castings, not to injure the coating, and no material of any kind shall be placed in said pipes and castings during transportation, or any time after being coated. If, upon its arrival at the designated point of delivery, the spigot end of any straight pipe should be found cracked or broken during transportation from the foundry or otherwise, such defective portion shall be cut off at the contractor's expense, provided that the same does not exceed a length of four (4) feet. A deduction from

the proper original weight of such pipe, shall also be made in each such case, at the rate specified in the table of weights, for every inch of length so cut off. No pipe or special casting in which the hub is found to be cracked or defective in any respect, will be accepted at said point of delivery or elsewhere; nor will any special casting with a defective spigot end be received or permitted to be cut off, without the written order of the engineer.

Pipe arriving with weight or number illegible or omitted, will not be received, but will be subject to the same conditions as cracked or broken pipe, so far as they apply.

All tools, men and materials required by the engineer in discharging his duties relative to inspection, contemplated by these specifications, shall be furnished by the contractor, and at no expense to the village.

QUANTITIES.

Following is an approximate estimate of the quantities of cast iron pipe and special castings, required for the construction of a water supply system for the village of Buchanan, Michigan, in accordance with the attached plans and specifications.

The sizes given refer to internal diameters.

The weight of straight pipe follows:

Size	Feet	Wt.per foot	Total weight
16 inches	50	133.5	6,675
14 inches	2050	109.7	224,885
12 inches	700	86.77	60,769
6 inches	30155	33	1,325,115
4 inches	26200	2022	524,000
Total	59155		2,141,444

Any pipe weighing less than the above by three (3) percent. will be rejected, and no allowance or payments will be made for any excess above these weights. These requirements shall be determined by the weight of each pipe separately. All pipes shall be of such length as to closely approximate twelve (12) feet from face to face of bell when laid in the ground, and the weight per foot shall include the weight of bell or hub.

The village shall have the right to, and may at any time previous to the shipment of the pipes and special castings,

change and revise these specifications as to sizes and amounts, as may be required by the needs of the work, without change in the contract rate of payment.

Contractors in making their bids, will specify the prices per net ton of two thousand (2,000) pounds for which they will deliver each of the different sizes named as per these specifications. Also price per pound for special castings made in the ordinary manner, and where necessary, according to the engineer's drawings. Detailed drawings of each size of pipe to be used in the work should accompany each bid.

The right is reserved to reject any and all bids.

LIST OF SPECIAL CASTINGS.

There will be required the following approximate quantities of special castings:

Crosses	Lees	90° Turns	Reducers
26 - 6" x 4"	22 - 6 x 4	1 - 12"	1 - 12 x6
1 -14" x 6"	6 - 4 x 6	5 - 6"	7 - 6 x 4
	4 -14 x 6		1 - 14x12
	1 -12 x 6		
	4 - 6 x 6		
	1 - 6 x14		

12 - 4" butt ends.

SPECIFICATIONS FOR
PIPE LAYING AND SETTING HYDRANTS,
VALVES AND VALVE BOXES.

The following is an estimate of the total length of each size of pipe to be laid:

Size	Feet
16 inches	50
14 inches	2050
12 inches	700
6 inches	30155
4 inches	26200
Total	59155

The work under this specification will include the setting of all necessary special castings in the pipe system throughout the village. Also the setting of about eighty-six (86) fire hydrants as specified below.

Also the setting of the following gate-valves with valve boxes:
One (1) sixteen (16) inch gate valve
Two (2) fourteen (14) inch gate valve
Twenty-seven (27) six (6) inch gate valves.
Nine (9) four (4) inch gate valves.

The above quantities must be considered as only closely approximate, and the right is reserved to modify them as may be found necessary in the progress of the work, without extra compensation to the contractor other than that due to the rate of charge for such kind of work.

The contractor shall furnish all

labor, materials and all plant necessary to lay the pipe in accordance with these specifications, and in a thoroughly first-class and workman like manner.

Any blow off air cocks, or other connections necessary to render the work complete will be set up by the contractor at points to be designated by the engineer.

The work will be done along such lines and streets as are indicated on the pipe distribution map of said water works system, and in such other places and streets in said village as may be directed by the village.

The contractor must begin work on or before—date to be set later, and he must prosecute the work diligently and rapidly from day to day and must complete the work within the time specified in his proposal. During each of the months of the time allowed for this work, a proportionate part of the work must be completed. The trenches for the pipes shall be opened under the direction of, and in accordance with the grades and lines to be given by the engineer and of such depth that the bottom of the trench shall be five (5) feet below the grade of the street. Along the same streets the pipes shall be laid uniformly the same distance from the street center, in straight lines and on straight uniform grades between the adjacent hydrants.

Any increase in depth beyond that which is necessary to lay the pipes in this

manner, if ordered by the engineer, will be paid for per cubic yard of earth excavated and back-filled, provided such extra depth averages three (3) inches or over for the whole length of the extra cut.

The greatest care must be exercised to insure public safety while the trenches are open, and until all cause of danger appertaining to the work, is removed, by fencing, shoring, watching, lights, etc., and the contractor will be held liable for all damages due to neglect of these precautions.

The pipe will be laid in the order directed by the engineer; and the storage of pipes and other materials on the street, and the laying must be so arranged as to cause the least possible interference with the public, and with the street, sidewalks and crossings.

In soft ground, each pipe must be laid on three (3) blocks 2 in. by 8 in. by 2 ft., three for each pipe laid equal distances apart.

Valves and hydrants, special castings, and all other appurtenances are to be placed at the places, and in the manner designated by the engineer, specified herein and shown by the plans.

Any omissions of branches, stopcocks or other appurtenances intended to be laid, shall be corrected when required, by reopening the trench, if it has been filled up, and introducing whatever may have been omitted and without extra charge

upon the part of the contractor.

In hard ground,the bed of the pipe must be even, true and uniform, so that the pipe will bear equally upon it for the whole of its length, and this result must be reached, either by carefully bottoming out the trenches, or by packing in and tamping solidly, sufficient earth to bring it to the proper grade. Sufficiently large holes shall be dug, to leave the bell of each pipe free, and not resting upon the ground at any point.

At the time of laying, the bells and spigots shall be truly adjusted so as to give a uniform lead space all around, and the depth of lead must not be less than two (2) inches, but must be more if necessary, in order to completely fill the rabbet in the hub or bell end of the pipe.

The lead must be of the best quality, pure and soft and must be calked securely and properly into place.

The gasket must be of clean hemp yarn or oakum, twisted and rammed tightly into place. Before making the joint the bell and spigot must be wiped clean and dry, and the joint run at one pouring. The calking must be faithfully executed, and the lead driven flush with the face of the work, or until it will set no further.

The pipes are to be swept clean and free from dirt and rubbish before laying, and at each time of stopping work, the end of the pipe must be carefully plugged and closed to exclude animals, dirt and water.

All streets and sidewalks, crossings, public or private grounds, shall be restored to their former and original condition, the same as before the work commenced, and in every way satisfactory to the engineer.

Great care must be taken not to remove, without the consent of the proper authorities, any gas pipes, sewers, drains or cisterns, or their appurtenances, and they must be carefully shored up, supported and protected, and the pipe laid in such a way as not to harm them. After passing the above with the pipe, the earth must be very carefully compacted about them. Any damage done to any of the above, or any other public or private property, must be made good by the contractor.

If any boulders be encountered in the trench, they must be taken out and moved off the streets or sunk so that the tops will not be less than one foot below the bottom of the pipe. No stone larger than one man can lift, shall be put back in the trench.

Whenever necessary to cross under, or in any manner interfere with a railroad, due notice shall be given to the superintendent of the same, and the crossing must not be made except with his approval as to time and manner.

In back-filling the trenches, the earth must be rammed carefully under and around the pipe up to its center. The rest of the trench may then be filled by depositing the earth in layers not to ex-

ceed six inches in thickness and ramming each layer thoroughly. No boulders will be allowed in the back-filling, within two (2) feet of the top of the pipe.

All unused or defective material, rubbish, etc., incident to the work must be removed at once, and the street kept clean. All pieces of pipe not shorter than three (3) feet must be used at once in the line; that which can not be used must be removed at once to a place designated by the engineer.

Whenever these requirements or any portion of them are neglected or unheeded, the engineer will give the contractor due notice to that effect, and if the rubbish, etc., is not removed, or the needed repairs made the engineer will have the power to employ men to do such work at the expense of the contractor, and these expenses may be deducted from any moneys due him from the village.

Before being accepted, the pipes will be tested to a pressure of one hundred and fifty (150) pounds per square inch, as shown by a correct gauge attached to any hydrant to be designated by the engineer. Any breaks, leaks, faults or defects in the pipes, or the work, must be made good and repaired by the contractor at his own expense. Such tests shall be continued until the engineer is satisfied that there is no leak or defective part in the whole system. The expense of this test (except the pay of those in the employ of the village) will be borne by the contractor.

The contractor must leave the work in perfect order, and it must stand any pressure, up to one hundred and fifty (150) pounds per square inch, to which the engineer may wish to test it, and must conform in every other particular to the specifications, both general and detail, so far as they apply.

The contractor shall maintain the pipe system in perfect order for a period of one (1) year from the time of its final acceptance by the village, and shall repair at his own expense, all breaks, leaks and faults, which occur in his work, by reason of faulty material or faulty workmanship, and shall pay all damages resulting therefrom. During this time he shall maintain the surface of the streets in their original and undisturbed condition.

Pipe laid, will be measured from center to center of special castings, on cross-lines, or from center of special castings to end of line, and from center of main to center of hydrants.

Where specials are inserted and plugged, measurements will be made to the end of the branch.

HYDRANTS.

All hydrants must be carefully examined by the contractor, to see that they are in perfect working order and free from rubbish, dirt, stones, etc., before setting them, and when defects exist, he must call the engineer's attention to the fact.

The trench to receive the hydrants will, in clay, open, porous, sandy or gravelly soil, be excavated of sufficient size, and at least one-quarter (1/4) of a yard of coarse gravel or broken stone shall be placed beneath and around the hydrants, up to a point one (1) foot above the drip, then the earth shall be tamped securely to the surface. In sandy or gravelly ground, enough broken stone shall be placed about the drip, to keep it free from clogging.

The foot of the hydrant shall be securely braced behind, to prevent injury to the bottom joint, and care must be taken to set the hydrants truly vertical. Each hydrant must be set truly at grade and will stand upon a flat stone 3 in. X 12 in. X 12 in.

SETTING VALVES.

The contractor must examine all valves carefully, and all found defective must be rejected. Care will be taken to see that all the dome and packing-gland nuts are set up tight and properly.

All valves will be set uniformly with reference to property or curb lines, as directed by the engineer, and no variation greater than one (1) foot from the uniform location will be permitted.

Proposals will be submitted in the following forms for the work as specified above:

Price per lineal foot for laying,
four (4) inch pipe.
six (6) inch pipe
twelve (12) inch pipe
fourteen (14) inch pipe.
sixteen (16) inch pipe.

The prices must include the setting of all hydrants, valves, valve boxes, etc.

SPECIFICATIONS
FOR
DRIVEN WELLS

There will be required six (6) six (6) inch tubular wells, to be driven at points to be located by the engineer. It is expected that water bearing strata will be encountered at a depth of about forty (40) feet from the surface of the ground. In any event the wells shall be driven to such a depth that the water, both in quality and quantity for domestic purposes shall be acceptable to the engineer.

The casing of the wells shall be of wrought iron, welded pipe, of a nominal internal diameter of six (6) inches, with screw joints, weighing approximately twenty-eight (28) pounds to the lineal foot.

In sinking the wells, every possible precaution shall be taken to drive the wells as nearly vertical as possible, and every possible precaution must be taken to make the joints water tight.

After the wells have reached the required depth, they shall be thoroughly sand-bucketed, and their ends fitted with a removable, copper point and strainer not less than eight (8) feet in length and of a pattern acceptable to the engineer.

It is expected that the water will rise in the wells to within about three (3) feet of the surface of the ground; but

in any event, they shall be connected together by six (6) six (6) inch pipes, below the flow line. These six (6) inch connecting pipes shall be fitted with stop-valves so arranged that the water may be drawn from any well without interfering with any other.

All details shall conform to the plans on file in the office of the engineer, and any other drawings that may be necessary to render the work intelligible, will be furnished by the engineer upon application.

FURNISHING MATERIALS FOR AND ERECTING REINFORCED CONCRETE RESERVOIR INCLUDING FOUNDATIONS, CONNECTIONS, ETC.

The reservoir intended to be built under these specifications will be located upon certain ground and within lines to be given by the engineer.

The excavation will be made to stakes and lines, and to the depth given by the engineer. The excavation shall be made two (2) feet larger in every direction than the extreme outside measurement of the work. The excavated material of whatever kind shall be placed wherever the engineer may direct within a distance of two hundred (200) feet. The contractor shall at his own proper expense, furnish all lumber, timber, bracing and shoring or other material necessary to firmly hold in position the banks or sides of the excavation during the construction of the work. The contractor shall at his own expense, furnish all the pumping machinery and power to operate the same, necessary to keep all of the ground water out of the excavation and entirely away from the newly laid concrete until the cement used in the construction has had ample time to become thoroughly set. The engineer will inform the contractor as to the time when the water may be allowed to accumulate around and about the work, and the contractor shall not allow the water to so accumulate until permission therefor shall be given by the engineer as above indicated. The contractor shall provide the necessary number of pump holes or pump pits for the collection of

ground water, from whence it will be pumped out as above set out. If in the opinion of the engineer, it shall be necessary to leave in place any of the sheeting or bracing, or other timber after the work is completed, then the contractor shall be allowed pay for such sheeting, bracing or timber so left by order of said engineer, as per price bid on same. No extra allowance will be made for any material which may be hard or difficult to excavate, which may be encountered in the prosecution of the work. The contractor must satisfy himself as to the nature of the material to be excavated before bidding upon the work.

The concrete composing the reservoir must be made of one (1) part cement, two (2) parts sand and three (3) parts broken stone.

The cement used must be of the best quality Portland cement, entirely free from lumps. The engineer shall have the right at any time, to make any tests of the cement that he may see fit. Should the cement so tested not withstand the tests satisfactorily it will be rejected.

The sand used shall be clean, sharp and fine and of a quality acceptable to the engineer.

The broken stone must be of the best quality and of a uniform size. The smallest stone must not pass a three-quarter (3/4) inch ring and the largest stone must pass a one and one-half (1-1/2) inch ring.

Before being placed in the work, the concrete must be thoroughly mixed, to the satisfaction of the engineer.

The reinforcement shall consist of square corrugated steel bars of a make acceptable to the engineer. They shall have a tensile strength of sixteen thousand (16,000) pounds per square inch and shall withstand the test of bending cold one hundred and eighty degrees (180^{0}).

The forms shall be made of planed sound lumber, free from all knots and windshakes.

The entire work must be done with skill and despatch and in such a manner that it will have a satisfactory appearance. Defective material and workmanship may be rejected at any stage of the work and must be properly replaced by the contractor as directed.

The reservoir shall be water-proofed by means of the Sylvester process or by a process equal to it in every way.

Provision shall be made in the bottom of the reservoir for a sixteen (16) inch supply pipe, and the joint shall be made perfectly water tight.

All inspections shall be made under the direction of the engineer or his authorized assistants and he shall have general supervision of the work.

FURNISHING AND SETTING UP PUMPING MACHINERY

There will be required one (1) horizontal, compound, non-condensing duplex direct acting pumping engine of the following dimensions:

Steam cylinder sixteen (16) inches diameter and eighteen (18) inches stroke: pumps sixteen (16) inches diameter and eighteen (18) inches stroke; provided with suction and discharge pipes; and connected by six (6) inch pipe with reservoir; and by sixteen (16) inch discharge pipe, with main, and to be set and connected as per plans.

The pumps as described under this specification, may be the Worthington, Deane of Holyoke, Mass., the Hughes of Cleveland, Ohio, or other manufacture equally acceptable and to be approved by the engineer. Bidders will state in their proposals what manufacture of pumps they propose to furnish.

The pumps shall be of double acting plunger variety with outside center packed plungers. These pumps will be required to work at a piston speed not to exceed one hundred (100) feet per minute against a domestic pressure of seventy-five (75) pounds per sq. in. of pump plungers, and a fire pressure of one hundred and twenty (120) pounds per sq. in. of pump plungers.

An appropriate air chamber shall be placed on the suction pipe, and one on the delivery pipe.

The contractor shall furnish and

put in place, a stop valve on discharge main, also a stop valve on suction main; these to be of same size as the pipe.

Pump to be of twenty-eight hundred (2800) gallons per minute capacity, and bidders are required to comply as nearly as their patterns will permit, with the dimensions given above.

The pump shall be furnished with an approved sight feed lubricator of one (1) quart capacity, and a full set of glass register oilers, and a set of brass polished oil cans and tray.

There will be required one (1) ten (10) inch brass case, nickeled water pressure gauge, attached to the discharge main, to be graduated to one hundred and eighty (180) pounds and also to be graduated in feet to four hundred and fifteen (415) feet. Also one (1) ten (10) inch brass case, nickeled vacuum gauge, attached to the main suction pipe and graduated in feet and inches.

The gauges to of make acceptable to engineer and to be mounted on neat walnut board at such a place as engineer may direct.

The pump shall be furnished with a reliable engine counter-connected to the rock shafts to record the strokes.

The proposals must give lump sum for furnishing all materials and labor whatever kind or description, for the construction, delivery and erection complete with

all appurtenances, and with foundation for two (2) motors and one (1) pumping machine, together with the suction pipes from the pump to and connection with pipe from the reservoir.

The contractor is required to furnish the concrete for the foundation which shall conform in a general way with plans on file in the office of the Water Works Committee.

The foundation shall be concrete not more than five (5) feet depth, surmounted by a cap stone not less than eight (8) inches thick, projecting from four (4) inches above the floor, with a two (2) inch wash.

In submitting proposals for the materials and work to be done under this specification, bidders will state the time for the complete delivery and erection of the plant. Other things being equal preference will be given to that proposal offering the earliest delivery and erection of the work.

During the last week of each month the engineer will make an estimate of the materials furnished and the work performed under this specification during that month. Eighty (80) per cent of the amount due, will be paid upon the fifteenth (15th) of the succeeding month. The balance twenty (20) per cent will be due and payable within sixty (60) days of final completion and test and approval by the engineer, and accepted by the Water Works Committee.

The right is reserved to reject any and all bids.

SPECIFICATIONS FOR PUMPING STATION

The building of pumping station will include the excavations for foundations and construction of same, in accordance with the plans and specifications and their expressed and implied intention.

Excavations shall be made according to the plans and approximately four (4) feet below the natural surface of the ground.

The bottom of the trench for the footing course shall be excavated truly level and rammed so as to provide an even bearing over its entire surface.

The foundations shall be built of a mixture of one (1) part Portland cement, three (3) parts fine clean sand and six (6) parts stone. This concrete may be machine mixed or hand mixed. The foundation for pump and motors shall be constructed in strict compliance with the plans. The top of the foundation shall be finished perfectly level.

On top of the foundation thus prepared a building shall be erected of the dimensions shown upon the plans. The walls shall be seventeen (17) feet high from top of foundation to level with eaves and the gable ends shall be twenty-seven and one-half (27-1/2) feet high from top of foundation to peak of roof. These walls shall be nine (9) inches thick, allowing for a two (2) inch air space.

All brick used in the construction shall be good merchantable brick of

uniform size and color and with sharp edges. They shall be laid in good well slacked lime mortar. They shall be laid truly to line and with one-quarter (1/4) inch joints; five courses of stretchers to one of leaders. All joints must be well filled with mortar and each brick well bedded.

All outside doors for building will be provided with cut stone sills not less than six (6) inches thick and of same width as the walls. All windows will be provided with cut stone sills not less than four (4) inches thick and six (6) inches wide.

All details of roof, rafter, ceiling, joists, ties, spacing, etc., shall conform to the plans. The ends of the rafters that project beyond the building shall be surfaced and framed so as to form a neat finish. The facia part shall not be less than four (4) inches wide. The ends of the rafters extending down from the building shall be covered with seven-eigths (7/8) inch beaded ceiling with beaded side down and the roof boards shall be seven-eigths (7/8) inch laid ship lap with the surfaced side down.

The brick work shall be carried up between the rafters and on a level with the top of same. A wall plate 2 X 8 inches shall be laid on top of the brick work and anchored securely by bolts. The rafters, ceiling joists and the beams shall be surfaced and all joints accurately made so as to present a neat appearance.

The roof will be covered with a

layer of tarred felt over which shall be placed red tiling laid with vertical seams. Over the center of the engine room shall be placed a galvanized iron ventilator of an approved design, not less than twenty-four (24) inches in diameter.

There shall be provided No 3 eight (8) inch whistle (bell chime). The whistle shall be set about six (6) inches above the roof.

All doors and windows shall be of size as shown in the plans. The material for the doors shall be of best quality, one and three-fourths (1-3/4) inches thick and shall be paneled as shown in the plans.

The door frames shall be made of two (2) inch thoroughly seasoned, and not less than eight (8) inches wide except for double door for main entrance which shall be 3 X 12 inches. They shall be securely set and firmly fastened on blocks laid in the walls.

The windows shall be of the size as shown on the plan; sash one and three-fourths (1-3/4) inches thick; all glass double strength American. All sashes shall have frames with suitable weights, pulleys, sash cords, etc.

There shall be provided a suitable trap door with hinges and ring, placed on the floor to give access to the pipe and fittings beneath.

The right is reserved to reject any and all bids.

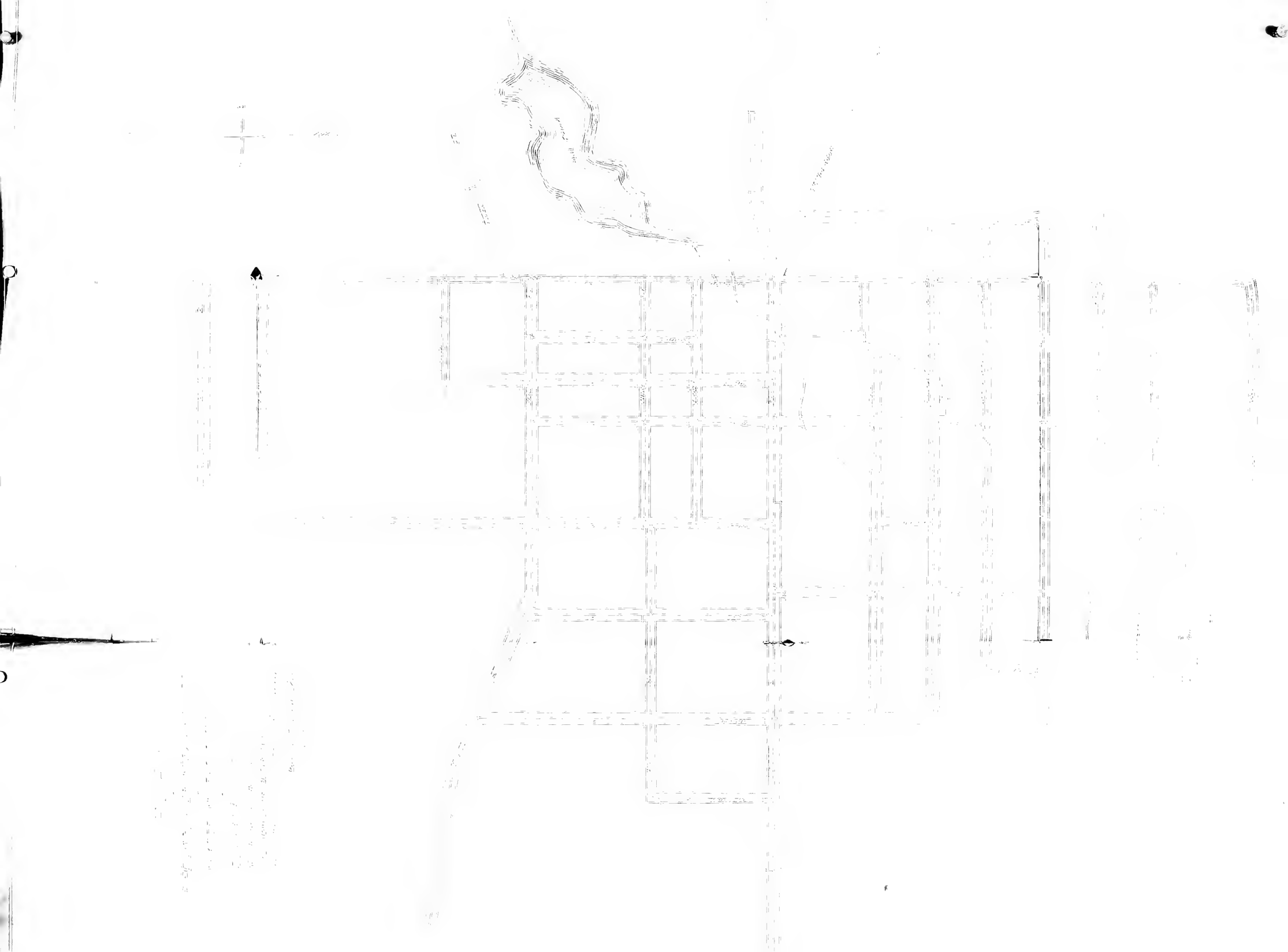
FURNISHING AND SETTING UP MOTORS

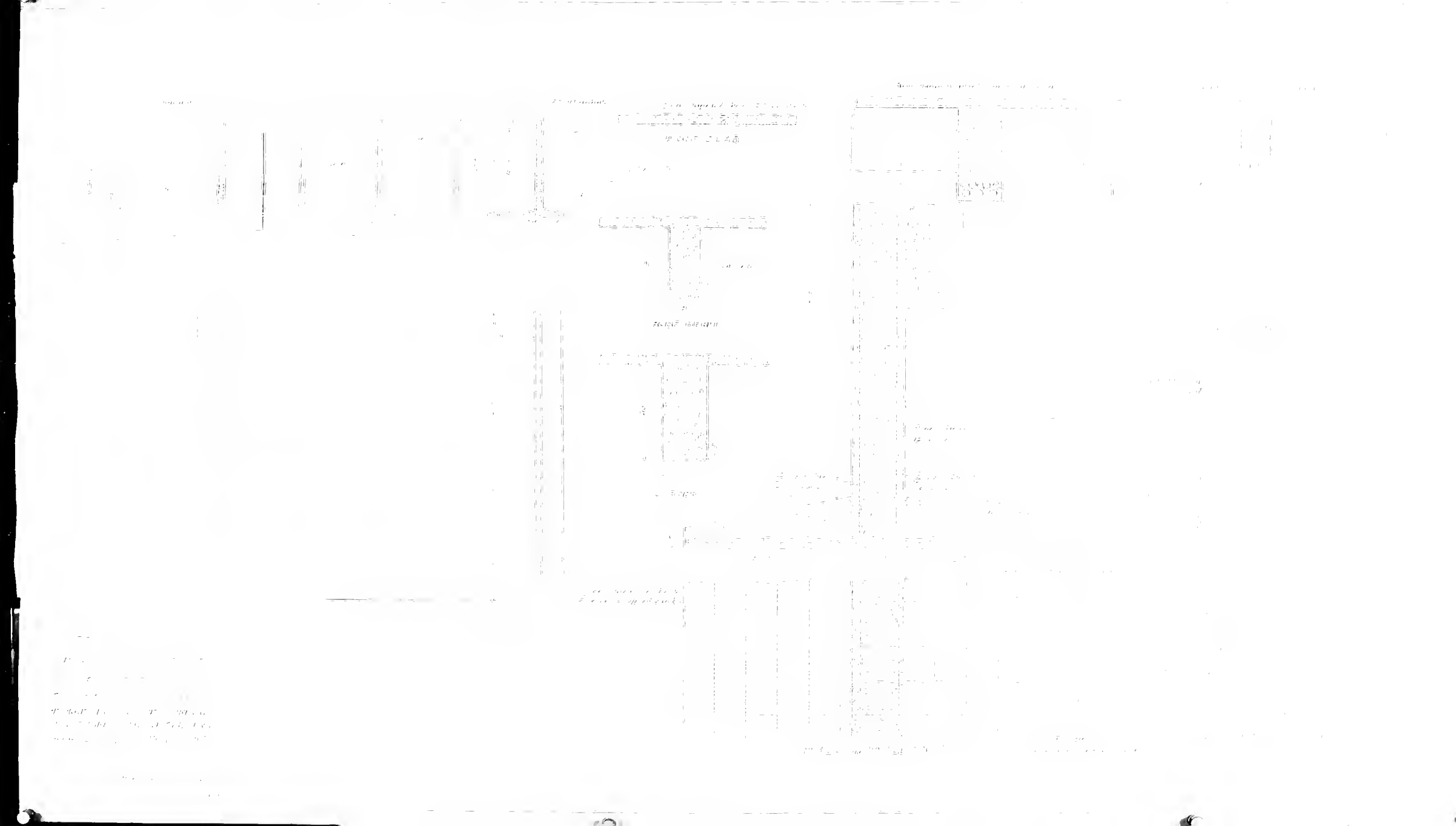
There will be required one seventy-five (75) and one forty (40) horse power three phase, sixty cycle alternating current motor.

They are to be of design approved by the engineer and are to be set up in such a manner that each will operate independently or together according to the load.

The right is reserved to reject any and all bids.

ARMORIE





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